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ABSTRACT

Promoting ACademic Excellence in Mathematics and Science for Workers of the 21st Century (PACE) was a consortium project made up of Indiana University Northwest, the Gary Community Schools, and the Merrillville Community Schools. The focus of this project was to prepare teachers and curricula for Tech Prep mathematics and science courses for the two school districts. The courses and course units prepared by the project are intended to promote the Core 40 Competencies of the Indiana Department of Education for High School courses. This document contains units for Physics and Physical Science designed to help students with a wide range of backgrounds and abilities learn physics. The Physics course includes the following units: (1) The Mathematics of Physics and Measurement; (2) Newton's Laws of Motion; (3) Electricity and Magnetism; and (4) Heat, Temperature, and Engines. The Physical Science course includes activities that link the traditional English, math, and physical science classes. Units in this course include: (1) Measure of Volume, Mass, Length; (2) Derived Measurements, Scalar Quantities; (3) The Chemical Industry; (4) Workplace Applications of Triangle Math; and (5) Motion and Energy. (JRH)

Physics and Physical Science Units for Tech Prep

PACE Promoting Academic Excellence in Mathematics, Science & Technology for Workers of the 21st Century.

Gary Community School Corporation
Merrillville Community School Corporation
Indiana University Northwest

Clyde Wiles, Director
Kenneth Schoon, Associate Director

Applied Units for Physics and Physical Science

Contributors

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Section One

Physics
An Applied Approach

Section Two

Physical Science
An Applied Approach

PACE

Promoting ACademic Excellence in Mathematics and Science for Workers of the 21st Century

PACE was a consortium project of Indiana University Northwest, the Gary Community Schools, and the Merrillville Community Schools. It was supported by funds from the three institutions and by Eisenhower grants from the Indiana Higher Education Commission.

The focus of the project was to prepare teachers and curricula for Tech Prep mathematics and science courses for the two school districts. The effort took place over 1994 - 1996 and involved more than 70 teachers from seven High Schools. The Director of the project was Dr. Clyde A. Wiles, and the Associate Director, Dr. Kenneth J. Schoon, both of Indiana University Northwest.

Part of the effort was the developing of units and course outlines for use in the first two years of a High School Tech Prep program. Individual schools and faculty will be using these materials in a variety of ways from being a course guide to being a supplement to an already existing program.

We have taken the position that Tech Prep is not a program for the academically deficient. Rather it is an applied approach to curriculum that has the goal of promoting competencies recommended by the State of Indiana for non-remedial high school courses, and which does so in a learning environment that emphasizes applications. We would like students to find within these course materials and instructional approaches immediate and obvious responses to the questions: "What does this look like?" and, "Why would anyone want to know?"

These courses and course units then are intended to promote Core 40 Competencies of the Indiana Department of Education for High School courses. For mathematics, we viewed this as beginning with Algebra One and for science beginning with Biology. The Pre-Algebra course is not a Core 40 course, but does maintain the applied perspective.

Our efforts have had to accommodate to several factors. First there is an Indiana mandate that all high schools have a Tech Prep curriculum that targets the academic and school-to-work needs of the middle 50% of the high school student population. There are on the other hand, persistent beliefs of counselors, teachers, administrators, students, and parents that something called "tech" anything, is just another name for a program intended for "at risk" students who are not expected to acquire competencies at a level that would enable them to pursue post secondary schooling at the college or university level. These beliefs are often supported by admission policies at some universities. We have, therefore, attempted to position Tech Prep courses as courses that meet exactly the same Core 40 competencies (as defined by the Indiana Department of Education) as are to be met by college prep courses of the same name, but to do so in applications-based and problem-centered approaches.

Clyde Wiles, Director
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Indiana University Northwest
Gary, Indiana
May, 1997

Physics
An Applied Approach

Introduction

This Applied Physics Course is designed to help students with a wide range of backgrounds and abilities to learn physics . The philosophy of the course is that students learn best when they become involved the subject matter. To that end this course strikes a balance between emphasizing the principles and concepts of physics to the solution of problems .

The main goal of this course is to make the physics experience more meaningful to high school students. By the end of this course, students should be able to apply their physics experience to real life situations in the world around them, including the world of work. This will be accomplished by brief lectures, skill demonstrations, cooperative learning, problem solving activities, hands-on laboratory experiments, and video media. Mathematical methods of laboratory measurement, scientific notation, significant digits, algebra manipulations, and graphical representations are used throughout this course.

Prerequisites for this course are: 1) A grade of 'C' or better in Algebra I, 2) A grade of 'C' or better in Geometry, and 3) Concurrent enrollment in Trigonometry.

Course Competencies:

At the successful completion of this course the student will be able to:

1) Demonstrate an awareness of the fundamental constituents of matter.
2) Measure or determine the physical properties including mass, charge, volume, temperature, and density of an object.
3) Use the concepts of temperature, thermal energy, transfer of thermal energy and the mechanical equivalent of heat to predict the result of energy transfer .
4) Use appropriate vector and scalar quantities to solve problems in one or two dimensions.
5) Describe and measure motion in terms of position, time, and the derived quantities of velocity and acceleration.
6) Use Newton's laws to predict the motion of an object.
7) Describe the interaction between stationary charges using Coulomb's law.
8) Analyze simple arrangements of electrical components in series and parallel circuits.
9) Describe electric and magnetic forces in terms of the field concept and the relationship between moving charge and magnetic fields.

Unit List

This course is now grouped into four units:

1) The mathematics of physics and measurement;
2) Newtons laws of motion;
3) Electricity and magnetism;
4) Heat, temperature, and engines.

More units will be written in *PACE '96*

Unit 1: The Mathematics of Physics and Measurement

This introductory unit for Applied Physics will allow students with hands-on activities to observe and record measurement. They will interpret their data using graphs and finding the uncertainty of their measurements. This unit will prepare them for success in this Applied Physics course.

Objectives: The students will be able to:

a. Demonstrate an ability to use metric instruments .
b. Perform arithmetic operations using significant digits and scientific notations
c. Learn prefixes used in the metric system and convert from one to another
d. Recognize that all measured quantities have uncertainties
e. Demonstrate an ability to construct a graph and use a graphing calculator.

Workplace Relationships

Architects, Building contractors and subcontractors
Doctors, nurses and health technicians
Engineers, mechanics and craftsmen
Food specialists
Tailors and fashion designers
Quality control personnel

Activities:

I. Divide student into groups. Have each group prepare a report on items that they find in their homes using metric units (tools, foods, medicines etc.). Have them interview relatives and neighbors to find what kinds of work or businesses that use measurements or metric instruments on a daily basis. Share answers with the rest of the class.

2. Each group will make several measurements using a metric ruler, balance and graduated cylinder of everyday items.

   a. Each student will choose a job role for their group.
   b. The students will:
      - record their answers
      - discuss why their answers may vary
      - tell how many significant digits in each answer
      - practice arithmetic operations with significant digits

3. The students in each group will be given different size milk and juice cartons, they should mark a point on the inside of each carton. They are to find the volume of the carton to the mark point in cubic centimeters. They will fill the carton with water (up to the mark) and find the volume in milliliters. They will also find the mass in grams of the water in each carton and record all of their results. (Find the mass of the beaker, then the beaker with water and subtract the final mass from the initial mass).

4. Each group will be asked to determine how many gallons of water it will take to fill an aquarium up to four centimeters from the top using only a metric ruler. The students will:

   -determine a method for solving the problem
   -decide when the will convert from the metric to the English system

5. Each student will be given a map. As a group they will measure distances from various cities in milliliters. They should change their answers to centimeters and using the scale on the map find the actual distances. Compare answers with other groups.

6. Each group should assume that they are to buy carpet and paint the classroom with the ceiling and walls a different color using only a meter stick and metric ruler. the carpet will be bought in square yards. Each gallon of paint will cover 53 square yards. They will do the following:
   - -determine how many square yards of carpet they will need
   - -decide how many gallons of paint they will need for the walls and ceiling
   - -find the average for all groups and discuss why some answers deviate from the average.

7. Using a micrometer measure several different types of wires. Write their answers in scientific notation retaining only significant digits.

8. Each group should receive three graphs Examples-mass/volume; time/distance; speed/distance). They will identify the dependent and independent variables. From any three points on the independent variable they should find the dependent variable and vice versa for each graph. Have each group think of five questions for the other groups to answer.

9. The group should be given a set of data to graphed. They will label the independent and dependent variables and determine the range. They should number and plot the points on the graph. The graph should have an appropriate title. Each group should compare their answers to other groups and discuss their differences.

10. Have members of each group construct a launching ramp. Put one end of the ramp on a stack of books and the other end on the floor. Mark off a distances 1,2,3,4,5 meters from the end of the ramp Using several different types of toy cars or balls record the time it takes to travel to the different distances and compute the speed. Make three recordings for each object and record the answers . Make a graph to compare the distance to each marker to the speed of the object for each car or ball. Enter the results in a graphing calculator and compare.

11. Using the CPL.. graphing calculator (TI-82) and motion detector students will predict how they have to move to show a straight line with a positive slope, etc. *The Dynamics of Walking.* Using Real Data in the Tech Prep Classroom, Enriwue Gaindo, 1995

12. Use the VCR with laser disk and bar code to show mathemedia: Module 4, Dr. Kloosterman, Indiana University, Bloomington , Indiana. Have students work problem for measurement section as they watch the video.

13. Have Students read "Physics and Society; Research dollars " (p. 7) and "To SI or Not to SI" (p 16) in Physics, Principles and Problems, Merrill Publishing Co. and discuss with the rest of the class.

Assessment:

1. Written tests or quizzes (each week)
2. Use CAP Generalized Cubic for:
   - 0 containing laboratory and written reports.
   - oral questions-asked of students after each activity
3. Group participation and attendance.

Unit 2: Newton's Laws of Motion

The constancy theme, particularly stability and equilibrium, is developed and expanded by the introduction of Newton's laws of motion. These laws unify a broad range of phenomena.

Objectives:

a) Explain how force between objects interrelate.
b) Develop a free body diagram of the forces operating on an object.
c) Student will be able to apply newton's three laws to real life situations.
d) Understand the difference between net force that causes acceleration and action reaction pairs.
e) Name the four basic force, their relative strength, and give some familiar examples.
f) Distinguish between Weight and Mass.
g) Demonstrate an understanding of frictional force and be able to use Newtons Laws in problem solving.

Suggested Laboratory Activities:

The following laboratory experiments are suggested from *Physics;* by Merrill.

1) Getting straight. P-28
2) The car race. P-50
3) The ball and the car race. P-70
4) The elevator ride. P-98
5) The paper river. P-114
6) The softball throw. P-140

Unit 3: Electricity and Magnetism

Electricity and magnetism is the foundation for various career choices from engineering to routine electrical maintenance. This unit will prepare students to go on to further their studies in electricity; whether these studies be in a traditional college setting, technical school, or apprenticeship training program. Through various experiments and activities utilizing actual equipment used by electricians, the students will learn the basics of electricity.

Objectives: Each student upon the completion of this unit will be able to:

a. Charge an object
b. State the difference between conductors and insulators
c. State Coulomb's law and the SI unit of charge
d. Solve problems using Coulomb's law
e. Explain the formation of electric and magnetic fields without charges
f. Show an understanding of Thomson's measurement of the charge-to-mass ratio of electrons
g. Be able to explain the right hand rule as it applies to force and direction of current
h. Solve problems using various electrical formulas
i. Describe a series circuit and parallel circuit, citing the difference between the two
j. Construct a combination parallel and series circuit
k. Calculate voltage, current, or resistance using the formula $V=IR$

Workplace Relationships:

Electrician
Electrical Engineering
General Appliance Repair
Computer, Radio, and Television Repair
Telephone Lineman
Electric Meter Technician

ACTIVITIES:

1. Electricity and safety (*Merrill Physical Science Activities Workbook* p. 25) In this activity students will discuss methods that may be used to increase the safety of ground level transformers and also determine whether the local utility company adequately labels all transformer boxes.

2. Identifying Electric Conductors and Insulators (*Physical Science,* D. C. Heath Chapter 8) Students use an electroscope to determine which objects conduct electricity.

3. Plastic Wrap and Static Cling. (*Physical Science,* D.C. Heath Ch. 8) In this exercise, students compare the cling strength of plastic wrap on different materials.

4. Dancing Paper (*Teaching the Fun Of Physics,* p. 100) Students charge a balloon and demonstrate that electric charge is strong enough to overcome the force of gravity to move paper.

5. Electromagnets (*Teaching the Fun of Physics*, p. 104) Students use two size D batteries along with a nail and aluminum foil to create a magnetic field.

6. How a Flashlight Works (*Teaching the Fun of Physics*, p. 104) Students use a battery and strip of aluminum foil to light a small incandescent bulb.

7. Circuits (*Physics: Principles and Problems*, p. 479) Students construct series, parallel, and combination circuits and determine current and resistance throughout the circuits.

8. Electric Motor (*Physics: Principles and Problems* p. 501) Students construct an electric motor to demonstrate their knowledge of the right hand role.

Unit 4: Heat Temperature and Engines

Objectives: The student will-

- distinguish between heat and temperature.
- identify and demonstrate temperature conditions necessary for heat exchange between objects.
- demonstrate the relationships between friction and heat.
- describe the difference between Celsius and Fahrenheit temperature,
- describe the process of heat transfer by conduction, convection and radiation.
- describe and illustrate methods that man can use to conserve heat energy.

Skills to be acquired

Measure temperature with a Celsius thermometer, measure temperature with a Fahrenheit thermometer, construct a graph, compare, measure volume, solve problems, define, explain, arrange, organize, group, list, convert, infer, submit, demonstrate, utilize, show and design.

Workplace relationships

Heating and cooling specialist, large engine repair (automobile, truck repair), small engine repair, building contractor (heating and cooling, insulation), fashion design (insulation), food service technician, laboratory technician, practical nurse, aircraft mechanic and ceramics.

Learning Activities / Teaching Strategies to use

HEAT and TEMPERATURE

OBJECTIVE: To be able to distinguish between heat and temperature.
Students will be able to-

- define heat and temperature.
- compare and contrast heat and temperature
- tell what happens to change in water temperature as mass increases.

MATERIALS: Ring stand, ring, wire screen, water, graduated cylinder, beaker, heating source, paper, pencil, and graph paper.

ACTIVITY:

1. Set up ring stand as modeled by teacher. Place over heat source.
2. Use graduated cylinder to measure 50 milliliters of water and pour into a beaker.
3. Using the scientific method, record under data the starting temperature for 50ml. Turn on the heat source and stir for 30 seconds (without thermometer). Place thermometer in the water without touching sides or bottom of beaker and after 60 seconds, record the final temperature.
4. Repeat the above steps with 150ml., 250ml., 350ml., and 500ml., of water and record the information.
5. Find the temperature change by subtracting the beginning temperature from the final temperature and record.
6. Construct a graph comparing the mass of the water with the temperature change.

Celsius and Fahrenheit Thermometers

Objectives: To see the relationship between Celsius and Fahrenheit thermometers.
Students will be able to-

- know freezing and boiling points of water in Celsius, Fahrenheit and Kelvin degrees.
- be able to convert from one scale to another.

Materials: Celsius and Fahrenheit thermometers, water, beaker, ice, heat source, graph paper.
Activity:

1. Using the scientific method, record under data the room temperature for both types of thermometers.
2. Make a chart (also under data) to record the temperature for every minute until the water boils for both Celsius and Fahrenheit.
3. Record the temperature using the Celsius thermometer until the water boils.
4. Repeat the above steps using a Fahrenheit thermometer.
5. Construct a graph (time vs. temperature) and show both sets of information.
6. As a member of a group record the temperature from a bank clock twice a day for several days in both Celsius and Fahrenheit degrees.
7. Record the high and low temperatures from the weather report for several days and convert to Celsius degrees using the formula $C=5/9\ (F-32)$.
8. Take several temperatures that were recorded during the activity and change from Fahrenheit to Celsius degrees and compare with data that they recorded.
9. Take the Celsius temperatures as recorded in the chart and change to Kelvin by adding 273 degrees to each.

CONDUCTION, CONVECTION and RADIATION

Objective: The student will be able to describe the process of heat transfer by conduction, convection and radiation.
Materials: Samples of copper, aluminum, glass, rubber, steel and wood strips, freezer (or ice), water, heat source and styrofoam cups.
Activity: Conduction

1. Place samples in freezer (or with ice) and leave for at least an hour before doing activity,
2. Using the scientific method, make a chart to record under data with numbers from 1 to 6 to write in names of samples from coldest to warmest.
3. Touch each sample with a different finger and rank with 1. being the coldest.
4. Measure 5 centimeters down from the top of a cup and mark with a pencil.
5. Fill cup to mark with hot water and record the time required (also under data) to feel the heat for each sample.

Objectives: The student will:

- be able to give examples of conduction, convection and radiation.
- observe that some materials absorb or reflect radiation better than others.

Activity Convection and Radiation:

1. Set up a ring stand as above with a beaker 3/4 full of water.
2. Add a drop of food coloring to one side of beaker (do not stir).
3. Gently warm the opposite side of the beaker and record observations.
4. Define the words conduction, convection and radiation.
5. Give examples of heat sources that keep you warm in cold weather and make a chart placing them under the headings of conduction, convection, or radiation.
6. Take two cups and make a lid for each, one with white and one with black construction paper.
7. Place each cup near a light bulb and record the temperature of each at the end of the class period. Compare the results.

Objective: To see how some materials conserve heat energy and are better insulators than others.
Materials: Containers (glass jars, tin cans, plastics cups etc.)with lids, insulating materials (cotton, aluminum foil, various fabrics etc.), graduated cylinder, ice, watch
Activity: INSULATION

1. Divide into groups of three or four people.
2. Each group should take various containers and cover each with an insulating material (tape if necessary).
3. Add ice cubes to containers and seal with lid and tape if needed.
4. Leave for at least 30 minutes.
5. Pour water formed in a graduated cylinder and record amounts for different combinations. Compare results.
6. Tell which substances were the best insulators.

Objective: To see how engines use heat energy to do work.
Activity: ENGINES

1. Have students divide into small groups.(three or four people)
2. Each group should list all engines that they see or use in everyday life.
3. Read their list to other members of the class.
4. Take their lists and divide into three groups (electric, gasoline or steam engines)
5. Each group should ask any family members who work with engines to tell them about their work and write a short report on what they learned to be reported to the rest of the class.
6. A visit should be arranged to the auto repair shop in the school if available.

OTHER SUGGESTED ACTIVITIES:

1. Have a maintenance person show students the heating system of the school and explain to them how it works.
2. Arrange a visit to NIPSCO (Public Service Company) to see how heat gets to our homes.
3. Visit a home that has solar heating and explain how it works.
4. Have a speaker who works with heating and air conditioning to explain about various aspects of their jobs and to illustrate various heating systems.
5. Divide the students into small groups and let them pick a type of heating system to make a model or drawings and make a presentation to the rest of the class.

Resources:

VIDEOS:

The Heat is On--The Effects of Global Warming , Solar Energy-- Hope for the Future , Weatherization and Insulation, Energy Conservation (Home Improvement), How the Automobile Works-- It's Really Not Your Enemy, Car Care Series-- Get the Basics, 1993 Power Steam Show-(Steam Engines-History).

BOOKS:

Modern Physical Science, Holt, Rinehart and Winston Inc., Harcourt, Brace, Javanoivich, Inc.; 1991.
Focus on Physical Science. Heimler, Charles H. and Price, Jack; Merrill Publishing Co., 1987.
Physical Science. Hurd, Dean and Silver, Myrna; Prentice-Hall, 1993.

Planning group members

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PHYSICAL SCIENCE
An Applied Approach

Introduction

PREREQUISITES: Algebra I, A or B. The students will be able to assemble simple lab apparatus in order to carry out scientific investigations. The students will be able to organize simple information into chart forms. The student will be able to do simple math operations using a calculator to help analyze data to make inferences. The students will understand the factor label conversion method and will be able to solve simple algebraic equations. The students will be able to do exploratory reading to collect mathematical information.

Description of the Course

The activities described within this teaching component allows a link between the traditional English, Math, and Physical science classes. The student will identify physical science in use within the Physical plants within their community. The students will survey how chemicals are used in our world to provide the basic needs for survival. The student will research types of chemical products produced within the community, identify the physical and chemical properties of these products, and their positive and negative Biological impact upon their community. The students will have hands on experience in collecting data using measurements with the concepts of science. They will discuss the interactions of matter in Physical, Chemical, and Nuclear reactions as they learn about atomic structure. The student will learn about the physical nature of matter through simple experiments relating motion, forces, and energy. They will also conduct experiments in an effort to understand how electrons and magnetic fields are harvested for energy consumption.

The types of scientific careers that are available involving Biology, Chemistry, and Physics will be identified and related to the basic scientific skills taught within the traditional Physical Science course. The educational level and skills needed to fulfill these jobs while learning the traditional objectives of a typical science curriculum will be used to setup a data base identifying agents that will provide post educational opportunities. Skills utilized by the students include; researching, experimenting, exploratory reading, organizing and sorting data, communicating through interviews like electronic conferencing and chat rooms, technical writing skills using computers, and problem solving skills flow charting through the cyberspace of a network in search of technical information.

The students will be assisted by the science teacher in surfing through the cyberspace of the World Wide Web to access and comprehend scientific data about the Industrial Plants within their physical community. The Science teacher will identify the science and math skills necessary for the types of scientific employment within the student's community, and expose the child to these skills using computer based lab experiments involving Math and Science. The students will record mathematical data used in technical writing collected using CBL's and scientific measurement interfaces. (i.e. charts, graphs, straight line transgressions, graphing calculators, computer spreadsheets, etc.)

Unit I: Measure of Volume, Mass, Length; Derived Measurements; Scalar Quantities

The students will learn how to use chemical apparatus to make simple measurement that Industries use in order to carry out their routine activities. The student will recognize the equipment, the calibration scales, and the appropriate units used to record data. With the use of charts, graphs, and diagrams; the students will be able to organize simple data recording physical properties and applying the data in making inferences. The students will report data using scientific method reporting numerical data with significant figures. Job simulations in product analysis, involving use of measurement to regulate the quantity of product output will provide practice in measuring length, volume, mass, and density. They will use collected data to calculate percent error and percent composition. Within this unit the students will add, subtract, multiply, and divide numbers. Throughout the unit the teacher will emphasize solving problems using the factor labor technique, and make use to recording data using significant figures. Emphasize how scientist use significant figures to record data with the same degree of accuracy. Also, emphasize how data can be manipulated using significant figures.

OBJECTIVES

1 The student will be able to engage in scientific inquiry with the ability to ask scientific questions and suggest experimental approaches to provide possible answers.
2 The student will be able to use physical properties to identify common metals and liquids.
3 Using standard safety techniques, the students will be able to observe and record scientific information using computerized measurement devices as well as the standard laboratory equipment. The students will record physical data indicating the uncertainty of the measurement.
4 The students will determine the dimensions, mass and volume of objects within the acceptable error of the apparatus. After measuring the mass and volume of an unidentified pure solid, the student will calculate density and use it to determine the identity of an unknown substance.
5 The student will understand the metric and mathematical relationship of length, mass and volume.
6 The student will be able to use the CRC Handbook, suitable electronic data bases, and the appropriate reference material to obtain relevant information for making scientific inferences.

Workplace Applications:
Method-Class Discussion
Time: 1 day

The class will have a discussion identifying the different types of measurements that are taken by technicians in various careers. Through a lecture discussion the students will be able to distinguish mass, weight, volume, length, and temperature. Guide the discussion to the following inferences;

1. Technical engineers estimate volume and mass of quantities being used and produces to efficiently make money to run their companies.
2. Dentist use metric rulers to find the depth of gum tissue around the teeth.
3. Pharmacist use measurement devices to determine the amount of medicine to dispense.
4. Grocery store use measurement devices to sell produce.
5. Hospitals use measurement devices to weigh patients and to dispense medicine appropriately.
6. Manufacturers use measurements to save by following recipes when making their products.
7. Doctors measure temperatures and vital signs to examine their patients.

Activity One
Laboratory- Measuring Volume- Did You Buy What They Said?
Time: 3 Days

Using a pint Rubbermaid servin saver; have the students observe how the metric volume unit in milliliters is listed. Have the students pour water to the 100mL line on the Rubbermaid container (record as expected). Using a graduate cylinder, have the student practice measuring the volume of water at the marked level (record as observed). Repeat these steps for the 200mL and 300mL lines. Have the student to make the same measurement using a small beaker, and then a larger beaker. The students will make up three charts to organize the three sets of data. The students will calculate the error percentage of their observed measurement and the expected measurement using the graduate cylinder, the small beaker, and the larger beaker. Have the student record the data collected from four other groups within the class to their charts. Have them calculate the average volume expected and observed, and calculate the percent error of the averages. The student should infer that the graduate cylinder gives the most accurate measurements.

Workplace application:

Have each group of students bring an unopened container of water. Have them measure the volume of the water within the container. They should report of the accuracy of the label. The students should discuss ways in which this information is useful to running a business effectively. The student should discuss way in which this information is useful to consumers.

Evaluation: Written explanation

1. The students will explain why the three devices had different accuracies.
2. The students will explain that each measuring instrument has a limit caused by the inherent error in the construction of the instruments.
3. The student will note that percent error represents the accuracy of the measurement.
4. The student will discuss how measurements govern profits.

Activity Two: Measured Metric Volume is Calculated Volume
3 Days

Remove the top of the juice container. The students will measure the length and the width of a pint juice paper carton or a half quart juice carton. The students will then mark the inside to the container 5cm and 7cm from the bottom (record this as the height of the container). Have students calculate the volume of the container at each mark(record this as the expected volume). Students will pour water to the 5cm mark and use the 50 ml graduate cylinder to measure the contained volume of water(record this as the observed volume). Repeat this at the 7cm level. The students will calculate the error percentage of their observed measurement from the expected measurement. Have them calculate the average volume expected, the average observed volume that they measured with the graduate cylinder. Calculate the percent error of the averages. Have the student to graph the expected volume verse the observed measurement. Have the students graph the observed water height verse the observed volume. Using this graph, have the students predict the volume of water at 6cm. The student should then mark the carton at 6cm and add water to the mark. Measure the volume using the graduate cylinder and see how their predictions compared to the measured volume.

Evaluation: Written explanation

- 20 pts. Charts
- 20 pts. Graphs
- 5 pts. for each measurement within 5% error
- 10 pts. Inference that one cubic centimeter is the same as one milliliter
- 10 pts. listing sources of error
- 20 pts. Teacher test over volume calculations and graphing

Activity Four: Mass Percentage (What part/ Whole X 100%)
Laboratory: Measuring Mass-How Much Did Your Chip Cost!
Time: 3 days

Using a triple beam balance, students will record the mass of an unopened bag of corn chips. Students will then empty the contents of the bag and record the mass of the bag. The students should calculate the mass percentage (percent composition) of the bag and the chips: using this number they will calculate the cost percentage of the bag and the chips. The students will record the mass of the chips within the container and compare that number to the expected mass indicated on the bag (calculate percent error). The students will count the number of chips within the container and record average mass of one chip. Using the mass of chip within the bag, the student will calculate the percent of broken and unbroken chips.

BONUS: Using percent error of product output, mass percentage of unbroken chips, and the average mass of one chip; the students estimate the number of chips in a larger bag of unopened chips.

Evaluation:

20pts Graph of Mass verse quantity.
20pts Sample calculations showing Average mass, Mass percentages, etc.
20pts Calculation for the Cost of the bag and the chips.
40pts Correctly estimate the number of chips in a larger bag by mass.

Activity Four: Method: Film Geometry Review
Time: 3 days

Using any geometry review film, students will view several short lesson that have questions at the end of each presentation. The students will view the lecture, stop the tape and discuss the film while practicing how to take numerical notes. They will the complete a teacher prepared quiz. Backup the video to allow the student to review the concepts while taking the quiz. The students should review, angles, shapes, area of shapes, volume of shapes, parallel lines, perpendicular lines, congruent angles, complements and supplements, angle and simple shape theories, spheres, radius, diameter, circumference, parameter, linear measurements. A laser Math interactive disc may also be used. Students will enter notes from the film into the Physical Science Notebook that they will write.

Evaluation: Interactive quiz on the video or laser disc.

Activity Five: Laboratory -Volume & Area of Geometric shapes
Time: 3 days

Using the multi-shape liter set (clear plastic cube, box, and cylinders with horizontal calibrations: the student will measure the dimensions of one box shaped container and one cylinder shaped container. The student will record length, height, width, and radius in centimeters. The student will choose two different calibration lines and calculate the volume for each container. The student will then pour water to the indicated calibration lines and measure that volume using a 50mL graduate cylinder. Calculate the percent error of the observed and calculated measurements.

Evaluation: Written explanation

20 pts. Charts
20 pts. Graphs
5 pts. for each measurement within 5% error
10 pts. Inference that one cubic centimeter is the same as one milliliter
10 pts. listing sources of error
20 pts. Teacher test over volume calculations and graphing

Activity Six
Laboratory - Density: The Mass/Volume Relationship Of Liquids
Time- 3 day

Matter is defined as anything that has mass and occupies space. All substances are composed of matter. All matter has properties or characteristics that allow specific substances to be described and identified. Mass and volume are two of these general properties. Density is the ratio of mass to volume. It is often defined as the quantity of matter (mass) per unit of volume. The density of a substance helps to identify it and to distinguish it from other substances.

Part A: Record the mass of an empty graduate cylinder using the electronic balance. To the cylinder add any amount of water, record this volume and record the mass. To get the mass of the liquid, subtract the two mass. Record the mass of the liquid in the chart in gram units. Calculate the density of the liquid by dividing the mass by the volume. The density is the mass of 1 mL of a substance and may be used to identify chemicals. Observe the density chart within the CRC Handbook to compare your calculations with the list of known chemicals. Have the students repeat this procedure using a different amount of water. Record both sets of data, and a set of data from another group. Have the student graph mass verse volume and explain their observations. The student should calculate the percent error for each measurement and the averages.

Part B: Using 4 different concentrations of salt water ranging from 1.5g/mL to 1.0g/mL, the students will calculate the density of the unknown liquid. The students will construct a chart, a graph, and have results within 5% error margin.

Evaluation: Written Report - Identification of an unknown liquid

10pts Recognize that the density was constant for all volumes of the samples.
10pts Recognize a direct proportional relationship between mass and volume.
20pts Construct a chart showing mass, volume, density, and % error.
20pts The student was able to graph mass verse volume.
20pts The student has percent errors less than 5%.
20pts Identified the unknown density of saline.

Activity Seven: Laboratory: Part A: Density of a Regular Shaped Object
Time: 3 days

The volume of a wood block with a regular shape may be calculated by multiplying its length height, width. (Volume = length X width X height= cubic units (cm^3 = 1 mL)). A solid may be weighed directly on the balance. Calculate the density of the wood block and compare your measurements to the density chart for identification. The percent error should be within 5%. Construct a chart recording the results of 3 groups within the class. Graph the mass verse the volume and find the best fit line. Calculate the slope of this line and compare it to the density of the wood. The student will compare the change in mass to the change in volume to establish a proportional relationship.

Using the value that the student calculated for the density of wood: have the students calculate the volume of a new block of wood and use the density to predict the mass of the block. Have the student to then record the mass of the block and calculate their percent error.

Evaluation:

20 pts. Calculation of the density of the wood showing all math calculations.
20 pts. Construction of chart.
20 pts. Graph showing mass verse volume.
20 pts. Recognize that the density is always constant like the slope of the line in the graph.
20 pts. Successfully estimate the mass of an unknown block of wood.

Part B: Record the mass of a 10mL graduate cylinder with 5 ml of water using the balance. To the cylinder submerge one teaspoon of your irregular shaped solid metal recording the new volume. To get the volume of the irregular solid, subtract the final volume from the initial volume. To get the mass of the solid, determine the mass of the graduate cylinder with the solid in it. Subtract the mass of the graduate with the water in it from the mass of the graduate with the water and metal. Record the mass of the solid in the chart in gram units.

Calculate the density of the solid by dividing the mass by the volume. The density is the mass of 1 mL of a substance and may be used to identify chemicals. Observe the density chart to compare your calculations with the list of known chemicals. The student should construct charts and graphs, writing a brief statement explaining how he identified the metal. (use Al or Cu shots). Repeat the same procedure two more times using different volume of water each time.(use 4 mL, 6mL, or 7 mL. The final volume with the sample should not exceed the limits of the cylinder.)

Evaluation: Written Report- Identification of an unknown Solid

10pts Use mass and volume displacement method to indirectly make measurements.
10pts Recognize a direct proportional relationship between mass and volume.
20pts Construct a chart showing mass, volume, density, and % error.
20pts The student was able to graph mass verse volume.
20pts The student has percent errors less than 5%.
20pts Identified the unknown density of Aluminum or Copper

UNIT II: The Chemical Industry

INTRODUCTION:

This unit provides students with an understanding of how chemical industries use the principles of chemistry to produce material goods and services. The function of the chemical industry is to chemically change natural materials into products that will make them more useful to society. Jobs today in this and related industries require people who have the ability to apply basic principles of chemistry. These principles include and understanding of: the composition and properties of matter, changes in matter, nomenclature and notation of matter, and how energy is involved in these changes.

Students will experience, first hand, how technicians apply their basic understanding of chemical principles. With a basic understanding of atoms, chemical and physical changes, states of matter, and recognition of chemical and physical properties; the students will discover how chemical technicians perform simple chemically related tasks required in manufacturing.

Objectives FOR Unit II

1 The students will be able to use appropriate nomenclature when naming and writing formulas to identify common natural and synthetic products.

2 The students will recognize the different forms of matter; liquid, solid, and gas. The student will be able to distinguish elements, compounds, mixtures.

3 The students will be able to use formulas and laboratory investigations to classify substances according to the presence of common anions and cations. The students will test for the following anions: phosphates, nitrates, and sulfates The students will test for the following cations: Potassium, Ammonium, and Ferrous III.

4 The student will be able to diagram reactants and products of chemical changes using sketches with the appropriate chemical notations

5 The students will use the periodic table and electronegativity charts to compare attractions that atoms have for their valence electrons, and the attraction that atoms have for electrons bonded in other compounds. The students will identify the atomic number, atomic, mass, chemical families and oxidation number of elements.

6 The students will recognize the indicators of a chemical change. The students will observe color change, temperature change, precipitation, bubbling, emitted light, ph change and energy changes as chemical change indicators.

7 The student will describe solutions in appropriate concentration units such as molarity, ppm, ppb, or percentage by mass or volume.

8 The student will make use of Colorimetric techniques used by analytical chemists to recognize color indicators of chemical changes as an indication of ion concentrations. The student will be able to quantify phosphate content in fertilizer samples

9 The students will predict how a reaction rate will be affected by changes of temperature, concentration, surface area, and use of catalysts.

10 The students will write lab reports using computer spread sheet programs.

Activity One
Method- Laboratory- Physical Properties
Time: 2 Days

Using a table with several element spread out, the teacher will lead a discussion about distinguishing things by their physical appearance. Spread out aluminum, zinc , lead, and copper. Have each element in several different forms; a sheet, powder, shots, wire and granules. Have a bottle of mercury, carbon powder, iodine crystals and tincture of iodine. Guide the discussion using the words, hard, soft, shinny, liquid, solid, heavy, light; and as many other properties that can be distinguished by the eye or touch. Have the student list the different properties on the blackboard. Have the students look up the names of the elements on the table in the periodic table and note their symbols.

Evaluation: Essay

The students will write a one page essay defining physical properties and how they are used to distinguish matter. The student should be awarded 5pts for every property that is discussed.

Activity Two
Method-Laboratory- Physical Changes By Change in Energy
Time: 2 days

Have a brief discussion about matter being changed from one form to another by a change in temperature, or pressure, or both. Discuss the following words; melt, condense, freeze, sublimation, boil, and evaporation. Also discuss how the kinetic energy of the molecules increases with temperature causing the forces holding the ice molecules together weakens. Using a thermometer, and beaker of ice in a small amount of water, plot the temperature change verse time as the beaker is heated slowly. First, stir the ice water until the temperature reaches 0 to 3 degrees Celsius, and place the beaker on a hot plate. Graph temperature verse time. Lead a discussion to make inferences on why the temperature remained the same at certain time periods.

Evaluation:

20pts Graph
10 pts Data chart
10pts Indicate on the graph where melting took place
10pts Indicate on the graph where boiling took place
10pts Indicate on the graph where heating took place
20pts Discuss how kinetic energy is related to phase of matter

Activity Three
Method-Laboratory-Indicators of Chemical Changes
Time: 4 days

Students will learn how to recognize the indicators that tell you a chemical reaction has occurred. The students will carryout several chemical reactions that may be classed as decomposition, displacement, combination, or combustion. The student will observe gas formation, color changes, heat formation, formation of precipitates, light production, or ph changes. The student will also practice writing simple chemical equations that represent the chemical mechanism that took place.

Part A: Using a strip of Magnesium, the student will record its' physical properties and then hold it in a flame and observe what happens.

Part B: The students will crush up some bread, and chop up a potato and drop some iodine on it. The student will observe a chemical change by dropping iodine on carbohydrates and observing a color change which indicate that a chemical reaction has taken place.

Part C: Using sulfuric acid and iron filings; the students will observe bubbling when Iron displaces Hydrogen within the sulfuric acid solution.

Part D: Using sugar in a test tube, the students will decompose it with heat and observe the gas (water vapor) escaping as the sugar molecules go through combustion.

Part E: Using a 0.1M Barium chloride and 0.2M Sodium Hydroxide, the student will observe a precipitate when 5mL of Barium chloride is mixed with 5mL of sodium hydroxide.

Evaluation: Essay and chart

10pts Awarded for each chemical change indicator mentioned
20pts Chart organizing the data

Activity Four
Method-Worksheet and MECC computer Simulation- The Atom
Time: 1 day

Using the periodic table and the Planetary model of an atom, the students will model the first 18 elements placing the electrons in the appropriate energy shells. The student will identify the shells as K, L, M, N, O, and P. The student will indicate the atomic mass as the number of protons and neutrons in the nucleus. Using the MECC computer simulation- The Atom, the students will answer question about atomic structure.

Evaluation: 75% score on the MECC Atom program using the models that the students made.

Activity Five
Method-Acids, Bases and Salts
Time: 1 day

Using Litmus paper, Calcium hydroxide, Sodium hydroxide, Acetic acid, Hydrochloric Acid, eye wash, mouthwash, lemon juice, orange juice, and sulfuric acid; the student will test to see if the chemicals are acids or bases. The litmus paper should be inserted into the chemical. The color of the litmus paper should be used to interpret the chemical as an acid or a base. Before the lab discuss polyatomic and monatomic ions. The student will understand the an acid is a substance which in water releases the positive charged monatomic ion hydrogen. Bases in the presence of water release the polyatomic hydroxide ion.

Have the students put 20mL of water into 10 test tubes. To the first test tube add one drop of dilute acid, to the second add two drops, to the third add three drops and so on until you have 10 drops of acid in the tenth test tube. Repeat the same procedure using any dilute base. Using ph Hydion paper find the ph of each of the base and acid Solution. To all of the test tubes add two drops of red cabbage juice and observe the variation in color as the solutions become more concentrated. Assign a color that the cabbage juice will turn for each ph level of the base and acid. The teacher will then give you an acid_and base of unknown concentration to you. Using the red cabbage juice, find the ph of you unknown acid and base.

Evaluation:

20pts Charts organizing data
20pts Color code ph chart
20pts Essay explaining how you arrived at the ph color code chart.
40pts Identification of the unknown base and acid ph

Activity Six: Preparing Solutions and Molarity calculations
Method: Lecture Demonstration - Lab participation
Time: One to Two Days

The teacher should equate Molarity of solutions as Concentration of solutions according to moles per unit of volume. Discuss weak and strong Kool-aide, using Sugar and Kool-aide as the solute. Review Solute, Solvent, and the mole conversions. Introduce Molarity as Moles per liter volume, and have the student do several math problems solving the 3 variable equation.

1. Have the students get 3 large beakers with 500ml of water.
2. To the first one add 1 scoop of sand; to the second 2 scoops of sand; and to the third 3 scoops of sand.
3. Explain that one scoop of sand represents one mole of compound XX. Have them record the mass of one mole of compound XX in grams.
   (molecular mass of compound XX=mass of one scoop of sand on the balance)
4. Using our 3 variable equation, have the student to calculate the molarity of the three solutions of sand.(ans. 2M, 4M, and 6M)
   Molarity = mol/volume = #of scoops / 0.5 L
5. Have the students determine the volume of one scoop of water using a 10mlgraduate cylinder.
   Scoop volume = Sample volume
6. Stir solution A and remove one scoop of the well mixed water- sand suspension.
   Place the sample on a preweighed piece of filter paper (practice proper filtration techniques). Place it in the oven to dehydrate the water. Weigh the dried filter paper with sand. Subtract the mass of the filter paper to get the mass of the retrieved sand.
   Sand mass = (Mass of filter paper + sand) - Mass of filter paper
7. Calculate the moles of sand that should be on the filter paper, by multiplying the calculate molarity (Step 4) by the volume of the scoop (step 5)
   Moles of sand= Molarity X Sample volume (L)
8. convert the moles of recovered sand to grams by multiplying the molecular mass of compounds XX (step 3) by the number of moles of sand (step 7).
   calculated grams of sand = Moles of sand X Molecular mass of Compound XX
9. Compare the calculated mass of recovered sand (step 8) to the observed amount of sand (step 6). Calculate the percent error. The student should be amazed to find that the numbers compare within 10% accuracy.

SAND MASS = CALCULATED GRAMS OF SAND

Alternatives:

Repeat same procedures....substitute salt or sugar and have the student to pour the sample into a small beaker.

Evaluation:

Have the student repeat the procedure on solution B, and C and let the filter paper dry over-night within their lab drawers. Have them calculate how much sand or salt should be recovered the next day, using steps 7 and 8. They should turn in the results before they leave class. When they return, they should complete step 6 and compare their number to that they turned in the previous day. They should be within the 10 % error range or they should repeat the procedure. (1 try A, 1 try with math errors B, 2 trys C, more F)

Activity Seven:
Method: Laboratory-Classifying Anion and Cation By Chemical Procedures
Time: One Week (Part A, B, C)

Work Place Applications:

In the next few experiments, the students will act as both as analytical chemists helping a farmer determine fertilizer content, and as a forester who will determine the soil ion content as it relates to the mutual relationship of plant survival and earth. The students will make the stock solution in part A; Test the known solutions and make the Expected reaction data chart in part B; and Test an unknown solution in part C. Have the students formulate a chart for recording data in part B, as a pre-lab group activity. Discuss the need for follow up testing for the presence of ions that may react in more than one test. Discuss how these skills may be important in the work of analytical chemists. Ask students to identify companies within the activity 1 database, that may employ analytical chemists. Relate how a farmer may need such help in determining the ingredients needed for their soil. Relate how the analytical chemist are important in environmental conservation.

Part A- Making solutions (evaluation of Sand activity)
Time: One Day
Method: Laboratory

Divide the class up into groups (up into 4 students). Have each make up one stock test solution for the ion testing lab, and one known solution.

Calculate the moles of solute needed to make the solution by multiplying the given molarity by the volume of desired solution. Moles = Molarity X Solute volume (L)
Convert the moles of solute to grams by multiplying the molecular mass of the solute by the number of calculated moles. grams = Moles X Molecular mass of Solute formula
Have the students pour this amount of solute into the indicated volume of water to make the indicated solutions.

Test solutions	Known solutions
100 mL 6.0 M Hydrochloric acid	100mL 0.1M sodium phosphate
100 mL 3.0 M sodium hydroxide	100 mL 0.1M sodium nitrate
100 mL concentrated sulfuric acid	100 mL 0.1M sodium sulfate
100 mL 0.1M iron (II)sulfate	100 mL 0.1M potassium nitrate
100 mL 0.1 M barium chloride	100 mL 0.1M ammonium nitrate
	100 mL 0.1M iron (III) nitrate

Evaluation:

The students will calculate the number of moles of solute required to make the known volume of solution. The student will then convert this number to grams. The student will be award 25 points for the following tasks.

Evaluation:

25pts.	number of moles illustrated in proper math format
25pts.	number of grams illustrated in proper math format
25pts.	pour 100mL in the graduate cylinder
25pts.	obtain the mass required on the balance and mix properly
100 pts.	

Activity Eight: Classifying Anion and Cation By Chemical Reactions
Part B: Collecting and Recording Data for a Control Reaction Chart.
Time: Three Days

The analytical chemist should have been one of the jobs identified at the chemical plants by the teacher. The student will then be asked to act as an analytical chemists in performing qualitative test to determine major ingredients in an unknown fertilizer sample. Using their ability to perform and interpret laboratory investigations, the students will test known solutions of the anions (Phosphates, Nitrates, and Sulfates) and the cations (Potassium, Ammonium, and Ferrous III) to set up a data chart for the expected results. The students will then perform the same tests on the unknown fertilizer solution in part C. By comparing the results, he should be able to identify which ions are present. Point out again that more than one ion can give the same results on any given test, thus, a follow-up confirming test is needed.

Additional Materials:

Phydrion paper	micropipets or eye droppers
12 tube spot plates	100 mL beaker with concentrated acid to clean wires
Wire loops	

Method: Laboratory

Using a spot plate the students should fill 4 tubes with one of the 6 known stock solutions. To each tub he should then add the following test solutions and record the results. Repeat this procedure with each of the remaining 5 solutions. Make sure you record the color of the original solution. The students will construct tables of the data that they collected in an effort to show which factors indicated a chemical reaction or positive result.(ph, precipitate, color change, temperature change, gas production, or light production) Once the Iron ion, phosphates and sulfates have been separated; the follow up test should be given to identify the nitrates, potassium, ammonium, and Iron ions.

Tub #	Test Solution	Expected Test Results
1	stock only	Color- Fe^{+3} is brown
2	2 drops NaOH	Precipitate with Fe^{+3} ions
3	2 drops $BaCl_2$	Precipitate with phosphates and sulfates
4	2 drops $BaCl_2$ + HCl	Precipitate of the phosphates will dissolve Precipitate of the sulfates will not dissolve

Follow up test:

Test for Nitrate ions- adding FeSO4 and H2SO4 to solution will leave a brown ring

Test for Cations only-

1. 2 drops of NaOH to a solution will turn litmus Blue if NH4 is present
2. Flame Test-

Chemical ion	Color
K+	violet
Fe+3	Sparks

3. Flame test through Co Glass

K+	Pink
Fe+3	Whitish

Activity Nine: Classifying Anion and Cation By Chemical Reactions
Part C: Evaluation- Identification of an Unknown Fertilizer solution
Time: Three Days (Part A, B, C)

The teacher will make up the unknown test solutions according to the following specifications. The test solution should be binary compounds with a minimum of one anion [Phosphate, nitrate, or sulfate] and one cation [potassium, ammonium, or iron (II)]. The test solution should be 0.1 Molarity. Examples of solutions are; potassium phosphate, potassium nitrate, potassium sulfate, ammonium phosphate, ammonium nitrate, ammoniun sulfate, Iron (II) phosphate, iron (II) nitrate, or iron (II) sulfate. The students will repeat the same procedures unassisted by the teacher. Make sure that each group has a different unknown solution. Tell the student to be very careful in comparing their results with other teams. Stress to them the importance of keeping track of the solutions within the depressions on the spot plates.

Evaluation:

40 pts. for each of the correct recorded data (8 Test x 5pts each)
10 pts. for making the appropriate charts
10 pts. for correctly identifying the unknown anion present
10 pts. for correctly identifying the unknown cation present
5 pts. for writing the correct formula
25 pts. for writing up the proper lab report.
100 pts. total

Ref.(Chem Com, Industry, Part C, page 245-247 Teachers resource book.)

Activity Ten : Colorimetric techniques
Method: Laboratory - HOW MANY DROPS DEFINES CONCENTRATION
Time: One Day

The students will discover that color can be used to indicate concentration of particles within a solution. The student will fill 10 test tubes with 20 ml of water and number them 1 to 10. The student will then put one drop of milk in the first, 2 drops of milk in the second, 3 in the third, and so on until the tenth has ten drops. The student should then explain how the transparency of each milk solution varies with the increasing number of drops of milk per solution. Have the students put each tube in a spectrophotometer and record the data. Using the Pasco 65 Mac Interface system and the Temperature sensor for Macintosh, or the TI-82 Interface CBL optic probe; the student will electronically measure the relative light intensity

Method: Laboratory - HOW MANY DROPS DEFINES CONCENTRATION

flowing through each tube. Have the students graph drops of milk versus the spectrophotometer meter reading, and/or the lux, and make inferences about the various opaques of milk and concentration of milk particles. The students should infer that concentration is the number of particles within a given volume. The teacher should relate ppm, and ppb after the experiment and tell how test for phosphates, carbon dioxide, and ph are used to read concentration of ions present using colorimetric techniques.

Evaluation: (Total 100 pts.)

25pts observation chart
25pts graph
25pts Interpretation relating number of drops to increased concentration of particles
25pts Lab report

Activity Eleven : Colorimetric techniques Indicating Phosphate Concentration In Natural Soil and Water Samples
Activity Three Field Project- PRACTICAL
Time: Three Days

Method: Laboratory (Part A-one day in the field)

The students will act like foresters who will determine the soil ion content as it relates to the mutual relationship of plant survival on earth. At the Deep River facility, the students will perform test on the soil and water at selected sites: the dam, the stream, and the lake. The students will compare the ph levels, phosphates levels, carbon dioxide levels, and nitrate levels present in the soil and water samples collected using commercial testing kits that make use of colorimetric techniques. The students will be put in groups of three. Each group will test a different area and ion. They will formulate charts in the field that will allow them to keep track of their data from the different test sites. The students will use colorimetric charts that will allow them to determine the range of concentration in ppb, or ppm. The students will compare the test data on graphs to show the relationship of levels on ions at the dam, the lake, and in the stream. Without teacher input, the students will formulate a hypothesis that will explain why the levels may vary at each site.

Part B- Two days in the lab, computer lab, or library
Method: Class Discussion, Lecture Participation, or Library

The first day in class the students should recheck their results using samples that were collected and transported to the classroom. They will be allowed additional time to research the uses of the tested ions within an ecosystem in an effort to understand why the ion concentrations level may vary. References: Chemistry books, library, or computer reference materials). Exploratory reading and surfing through the WWW and Computer MUSIC village will allow the student to connect to Comptom's encyclopedia, Universities and Environmental agencies in an effort to analyze the levels of ions that were found within the tested ecosystems. This will also help them to understand how the health of the community is affected by the products and pollution of industries.

The second day in class the students will discuss how the ion concentrations varied from the dam, the lake and the stream. The students will discuss how these levels are necessary for the survival of the organisms that live within each ecosystem. The students will discuss the nitrogen cycles to determine how atmospheric nitrogen gas is converted into the nitrogen compounds that can be used by plant life. They will also infer that the high levels of nitrogen in the soil is also a result of decomposing dead plants and animals. The students should understand that the nitrogen is recycled by bacteria back into atmospheric nitrogen. Note that nitrogen is 80% of the atmospheric gases.

Evaluation: (Total 100 pts.)

25pts observation charts
25pts graphs
25pts Interpretation of charts diagramed by the graphs
25pts Lab report

Activity Twelve- Chemical Energy and Electrical Energy Thermodynamics
Method- Laboratory
Time: 1 Week

The vast amount of energy needed to power industrial and domestic units is supplied by chemical reactions that release energy as heat. Compounds are held together by electrostatic bonds that store energy. Energy is required to break these bonds, but energy is released when these bonds

are broken and reformed. Products of Industrial companies are a results of chemical reactions breaking bonds of raw materials and forming new arrangements of bonds with different elements. The reactants and the products of these reactions have a different level of stored potential energy referred to as chemical energy. The nature of the chemical energy is the overall result of the type of bond, positions of the bonds, and the form of the elements in the chemical combination. Some chemical reactions release energy, while other absorb energy. We will investigate the nature of endothermic and exothermic reactions in supplying energy for our everyday living purposes. The student will observe how heat transfers from hotter to cooler surfaces until thermal equilibrium is achieved. The students will observe that molecules within a chemical system move from higher concentration to lower concentration in an effort to achieve chemical and thermal equilibrium just like heat. We will discover ways that we can regulate the reaction rate. The students will predict how a reaction rate will be affected by changes of temperature, ion concentrations, surface area, or catalysts while using Computer and calculator interfaces to collect experimental data. Pasco 65 Mac Interface system and the Temperature sensor, or the TI-82 Interface CBL . The first steps to understanding thermodynamics or Kinetics is to collect experimental data under a variety of conditions.

Activity Thirteen: Heat Transfer Achieving Thermal Equilibrium

Time: 2 days

Method: Laboratory

Using the Pasco 65 Mac Interface system and the Temperature sensor, or the TI-82 Interface CBL temperature probe; the student will electronically measure the initial and final temperature of a cold beaker of water before and after a piece of iron heated in a flame is introduced. The student will measure the hotness of the cold beaker of water, and then heat an iron bar in a flame. The student will then take the temperature sensor and put it in the beaker of water. The student will plot the heat change (temperature) verse time on the computer or CBL devise of the bar entry creating temperature changes as equilibrium is achieved. The student will then get a beaker of water chilled with ice cubes, and a beaker of boiling water. The student will add to each of these beakers one drop of food coloring and make observations. The student will then relate the behavior of the temperature changes to that of the motion of the food coloring dyes. Have the student research the following topics in an effort to explain what happened within each experiment; Principle of the conservation of energy, Heat, Thermal energy, Radiant and electrical energy, nuclear energy, and thermochemistry. Ask students to research computer data bases to see the types of energy sources used industrially today, and the examine the choices of the future.

Evaluation: Formal Lab Report(10 pts charts, 20 pts report, 70 pts inferences)
(10 Points will be awarded for each of the following inferences)

1. Thermal energy is associated with the motion of atoms or molecules in solids, gases, and liquids speeding up chemical reactions. Temperature is a catalyst.
2. Heat is a form of energy associated with changing the temperature of a substance.
3. The Higher the temperature, the greater the motions of the atoms in materials.
4. Electrical energy can be harvested form mechanical devices and chemical reactions.
5. Chemical sources are currently of considerable interest in replacing oil and coal driven mechanical generators.
6. Energy and molecules move from higher concentration to lower concentrations to reach equilibrium.
7. The students will identify the exothermic fuel-burning reactions releasing thermal energy, or heat as the main source of energy on earth.

Activity Fourteen: Catalyst Initiated Endothermic / Exothermic Enthalpy
Part A :Method: Laboratory-Demonstration
Time: I day

The students will observe the temperature change associated with the heating device "The Heat Solution"(heating pad) and the cold compress used at a Hospital. For the hot and cold compresses, there should be a large and a smaller one. Using the Pasco 65 Mac Interface system and the Temperature sensor, or the TI-82 Interface CBL temperature probe; the student will electronically measure the initial and final temperature of both systems. They will discover the difference between endothermic and exothermic chemical reactions, while observing a catalyst starting the reaction in the heating solution system. The student will sense the heat transfer from the plastic bag containing crystallizing sodium acetate (the system) to their hands (the surroundings). The crystallizing process will also give a visual of the concept of heat transfer. The phase change of liquid sodium acetate to solid sodium acetate crystals is exothermic. Using the commercial specific heat of Sodium acetate, the student will attempt to calculate the heat transferred to their hands. The Cold Comfort Instant compress containing ammonium nitrate is an endothermic reaction absorbing heat from its surroundings making it very cold. The bags will simulate a cell, the student will relate that cellular reactions usually occur at constant pressure; therefore, the heat trans-ferred into or out of a system at constant pressure is defined as a change in enthalpy. At constant pressure enthalpy is equal to heat transfer. Armed only with the information that Heat Capacity is the amount of heat energy needed to change the temperature of 1.0g of a substance by 1 degree Celsius, the mass of the system, and the temperature data; the students will calculate the enthalphy on both systems.

Activity Fifteen: Spontaneous Endothermic and Exothermic Reaction Kinetics

Part A :Method-Laboratory Ammonium nitrate readily dissolves in water. This solution process is endothermic, the enthalpy change in forming a solution is +26.4kJ/mol. The solution process of sodium hydroxide is exothermic, the enthalpy change in forming a solution is -44.48kJ/mol. Have the students dissolve 5g of Ammonium nitrate into 100 mL of water, and dissolve 5g of sodium hydroxide into 100 mL of water. Using the Pasco 65 Mac Interface system and the temperature sensor, or the TI-82 Interface CBL temperature probe; the student will electronically measure the initial and final temperature of both systems. Have the students repeat the experiment using 10g of sodium hydroxide and ammonium nitrate. Students will determine an experimental value for the specific heat of each sample and compare the temperature change for each system. The students will calculate the percent error using the commercial value from a chemistry handbook. The students will also calculate the molarity of each experiments and compare how each system varied. Have the students propose sources of error. (Use a calorimeter constructed from two polystyrene cups. The cork or cardboard top must fit into the cup having a central hole for the sensor probe.)

Part B: Method- Laboratory: Kinetics: Have students calculate the Calorimeter constant for the calorimeter used. They then drop 1g of aluminum into each of the sodium hydroxide solutions and observe what happens. Have students observe the motion of popcorn in a microwave as the temperature increases. The students will get 2 beakers and put crush one ice cube and 100 mL of room temperature water into each. Label the $\mathbf{A}_{control}$ and $\mathbf{A}_{stir}$. Then get two more beakers and label them $\mathbf{B}_{control}$ and $\mathbf{B}_{stir}$. In each put one ice cube and 100mL of room temperature water. Using the Pasco 65 Mac Interface system and the temperature sensor, or the TI-82 Interface CBL temperature probe; students will electronically measure the temperature change after stirring the each systems for 2 minutes. After the 2 minutes students will observe the amount of undissolved ice. They will predict how a reaction rate will be affected by changes of temperature, ion concentrations, surface area, and use of catalysts.

UNIT III: Workplace Applications of Triangle Math

The student will first learn the simple math functions that involve right triangles. The simple algebra and geometry principle involving measuring triangles such as angle measure, recognition of triangular patterns in everyday life, adding angles, measuring perimeter, calculating area, and applications of Pythagorean's theorem will first be reviewed. The student will also cover Sin, Cos, and Tangent laws. After viewing a geometry interactive film, the students will perform several experiments that will give them practical experience as a carpenter building a house. They will discover how carpenters use triangle math to build houses and estimate distances. The students will examine how crystals naturally grow in triangular and cuboidal patterns. Using a CAD drawing program, the students will discover how architects use triangles, squares, and circles to design houses, cars, and tools of everyday life. However; upon the completion of the model house that they will build and illustrate, they will discover that the math for add vectors in physics is the same. The math for the applications in adding vectors, forces, velocity, displacement, and roof pitch is the same. The only difference is that the adjacent side, the opposite side, and the hypotenuse side will have different names.

OBJECTIVES

1. Students will be able to use the appropriate vector and scalar quantities to solve problems in one and two dimensions.
2. Students will be able to apply Sin, Cosine, and Tangent laws to solve two dimensional problems as they relate to displacement, velocity, and force.
3. Students will be able to apply Pythagorean's theorem (that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides)to solve displacement, velocity, and force problems. The student will be able to graph these vector quantities.
4. Students will measure angles, force, mass, distance, time, area, and weight; diagraming them as they relate to the results of interactions between objects.
5. Students will express vectors in horizontal and vertical components in order to graph them, add vectors, and use this information with simple algebra and trigonometry to solve problems.

Activity One:
Laboratory:How Lapidaries Use Triangles and Squares
Time: 3 Days

Using mineral samples: students will examine how minerals are made up of one or more kinds of atoms arranged in a definite pattern called a crystal. Have students examine crystals of salt, calcite, quartz, topaz, halite, galena, pyrite, and gold; students should make the inference that the repeating patterns of triangles and squares make up the faces of most crystal. Have students draw and cut out planar shapes of crystals diagramed and glue them together to make the three dimensional shapes. Give students the dimensions of the squares and triangles that make the shapes. Students will reproduce a model at the scale that the teacher indicates. The figures should be at least 5cm. The students will measure the angles that make the shapes and identify parallel and perpendicular lines. Have students make charts and classify the minerals according to their crystal shapes.

Evaluation: Constructed models (*Principles of Science*, Book one, Merrill, 1979, pg. 65)

10 pts for each model assembled neatly
10 pts for correctly measuring the sides and angles of each model
20 pts for correctly identifying the mineral shapes

hexagonal:	calcite and quartz
orthorhombic:	topaz and sulfur
cubic:	galena, halite, pyrite
octahedral:	gold, fluorite

Activity Two: Pre-Math for Vector and Scalar Unit III
Laboratory: Pitch of a Roof - A simple ratio of two sides of a Triangle
Time: 3 days in computer room- Carpenter's applications

Using pictures of various roof, the students will use a CAD computer drawing program to diagram simple cubical houses and roofs. The student should draw the houses at the scale such that the floor will be 4 inches X 8 inches with a ceiling 5 inches high. The roof should be the pitch of 1/2, with a run of 2 inches. Using the simple geometric shapes within the CAD program, the student will make use of squares and triangles to draw any two of the types of roofs indicated. (1)lean-to, 2)saddle, 3)hip, 4)gambrel,5) mansard, or 6)ogee roof). The students will indicate all linear measurements , angles and functions used to make the scaled models. Recognizing that pitch is the ratio of the triangle height to its base as a fraction, the student will calculate the appropriate pitches of the indicated diagrams.

Evaluation: Computer CAD Drawing (ref. Webster Dictionary)

20pts Calculation of the pitch of model 1 and model 2 roof.
60 pts Use of the CAD program to reproduce the 6 houses.
20pts Brief description of the use of the computer functions to reproduce the drawings.

Activity Three: ENGINEERS MAKE PAPER MODELS FIRST
Laboratory: Paper Saddle or Gamble roof House
Time: 3 days

The students will make a paper model using the method that they used to make the paper crystal models. The students should use squares, and triangles with glue tabs and draw a planar diagram of the model they will scale. The student construct the houses at the scale such that the floor will be 4 inches X 8 inches with a ceiling 5 inches high. The roof should be the pitch of 1/2, with a run of 2 inches. Encourage the students to use the crystal shapes as a model for their schematics of the models.

Evaluation: Construction of a paper house

100pts	neat sharp corners, straight edges, proper dimensions.
80pts	corners don't fit sharply, proper dimensions
60pts	sloppy with uneven sides

The students should pass with 80pts. (All others should try again.)

Activity Four: CONSTRUCTION HIP-RAFTERS-VECTORS
LABORATORY: Pythagorean's Triangle Math in Carpentry
Time: 3 days

The student will use Pythagorean's theorem (that the square of the hypotenuse of a right triangle is equal to the sum of the squares of the other two sides) to decide what length to cut the hip-rafters of a model roof. The student will measure the rise and the run of a triangle.
Using Pythagorean's theorem calculate the hypotenuse formed by a right triangle whose inner side A is 2.5 units and side B is 3.75 units. Cut a piece of wood splint the length that was calculated. Using Trigonometric functions calculate the resultant angles that each end of the hip-rafter must be. Calculate Tan theta and then use the inverse Tan law to get the degree measurement of angle b.

The student will use the sums of the angles of a triangle to find the expected measurement for angle a. (Angles a+b+c= 180^) Using a pair of scissors cut the ends of the hypotenuse the measurements that you calculated for angle a and angle b. Glue all of the piece of wood together on a piece of centimeter scaled graph paper. Using a centimeter ruler measure the length of C to see how

it compares to the value that you calculated for the hypotenuse. Count the block enclosed by the triangle on the graph paper and estimate the area of this surface. Using the equation for the area of a triangle, compare the block that you counted to the number that you calculated. In all instances calculate the percent error between the expected calculated values for the hypotenuse and angles to that of the measured values. Repeat this procedure using 1/8 and 1/4 inch craft wood.

Evaluation: Chart and Hip-rafter construction

20pts Calculations showing the Hypotenuse
20pts Calculations showing the measure of angle b
20pts Calculations showing the measure of angle a
20pts Calculations showing the pitch
20pts The wooden triangle with tight fitting corners and % errors less than 5%.

Activity Five
LABORATORY: DISPLACEMENT, VELOCITY AND FORCE FOLLOW TRIANGLE MATH
Time: 3 day- Lecture Participation Adding Velocity Vectors

Take two large metal balls of equal mass and roll them slowly toward each other at a 90 degree angle; observe the path of the balls at the point of their collision. Each ball has its own magnitude and direction but the resultant path is the vector sum of the two vectors acting at the same point. The system makes a Y schematic at the instant of impact and then they separate on a path different from the original at a common angle at the point of impact.
Using the Relationships of Triangles, the resultant vector's angular direction should always be in reference to the positive "X" axis. The complement of supplement angle is sometimes used. Give the students velocity vector additions problems using vectors at right angles; have them repeat the same type of calculation that they had to do for displacement problems making the hip-rafters.

Sample Problem: An airplane was flying due east at 300mph. If a wind at 50mph blew the plane due north, what would be the resultant flight of the plane.

Activity Six
LABORATORY: DISPLACEMENT, VELOCITY AND FORCE FOLLOW TRIANGLE MATH

The student will be able to diagram the vectors on graph paper. Working on the board, have the students diagram vectors using sample problems. Use for instance: the boat crossing the flowing stream, the airplane being pushed up or down by wind, or a child pushing a lawn mower,

Evaluation: Quiz - Vector Addition Diagrams

The students will be given 2 vector problems to solve.
20pts Calculations showing the Hypotenuse
20pts Calculations showing the measure of angle B

Activity Seven:
LABORATORY: FORCE VECTOR AND TRIANGULAR MATH
TIME: 3 DAYS

Using a force board with three scales, place the scales so that two scales that are 90 degrees from each other. These scales represent vector A and B. Position the third scale so that the tension on that scale balances the other two that are at 90 degrees; this scale represents the resultant

vector C. Record the value on the scales. Trace the path of the intersecting lines recording angles. (You should draw a Y pattern.) Use Pythagorean's theorem to calculate the resultant force using force A and B. This calculated force should be within 5% of the measurement read off the resultant scale (vector C). Repeat this procedure two more times changing the tension on each scale by tightening the support strings. Calculate the % error between the observed and calculated resultants. The student will practice the same calculations as the displacement, and velocity experiments. Have the students graph the force vectors, making the right triangle using A, B, and C. The students should observe that the Vector connecting sides A and B has the same units on the ruler as the digits on the scale.

Evaluation: Graph and Calculations with a Short Quiz

20pts(each)	Calculations showing the resultant vector for 3 trials.
10pts	Inference that Force is a vector quantity following Triangle Math rules.
10pts	Calculations within 5% error.
10pts	The student will make the inference that a vector may be represented with an "X" and "Y" component.

Activity Eight: THE RESULTANT VECTOR
Laboratory: Arithmetic- Vector Addition
TIME: 3 days

Using the scale, weigh a wooden block. The student will take the wooden block with a loop on each side and attach to it two equal masses. Place the block on a platform table such that the weights hang off the platform (use a board supported by a table). To cut down the frictional force created by the table, put the block on top of 5 pencils so that it can roll freely. The student will record what happens. The student will then put weights of unequal mass on the block and repeat the same procedure varying the masses. The student should record the results using 100g, 200g, 500g, and 1kg masses. The student should explain what causes a change in horizontal motion?

Using a Helium balloon, have the student to tie the balloon to a 0.5g mass. Increase the mass in small increments and record the results in an effort to find a mass that would suspend the balloon in mid air. Push the suspended balloon in one direction and observe its path. Now repeat the same procedure pushing the suspended balloon in the path of a fan and observe the resultant path created by two forces. Once that is achieved, find the mass necessary to weight the balloons down.

Workplace application-

How is this information helpful to a person running a balloon shop that weights balloons with candy? How does a Helium or hot air balloon work? If two nine year old children and an adult had to move a table, how should they position themselves around a table?

Evaluation: Written statements after discussion with valid numerical data

10 pts	The student makes the inference that balanced forces cause no motion.
10pts	The student makes the inference that the force created by the pull of gravity on the attached mass must be exceeded to cause motion.
15 pts	The student understands that vertical and horizontal opposite forces are subtracted or added to find the resultant force.
5pts	Gravity is identified as a vertical downward force acting on mass.
5pts	Bonus if the student can suspend the balloon.
20pts	Chart containing organized numerical data.
20pts	Explain the workplace applications.

Activity Nine: GRAVITY IS A VERTICAL DOWNWARD FORCE
Laboratory: Calculate the Acceleration of Gravity
Time: 2 days

Using a scale, suspend a 50g, 100g, 200g, 400g mass from a spring scale and record its downward force. Then select any 4 objects within the classroom and measure its mass on the balance, and its downward force using the force scale. The student will then graph mass verse force, and force verse mass. The students should determine the math ratio of mass and force by dividing the two numbers. Have them divide both mass by force, and force by mass. In both cases the students will see that the ratio will be the same for each set of data. Have the student to calculate the slope of the lines formed on both graphs and compare this number to their graph. Then write the acceleration of gravity on the board. Ask the student to explain how this number compares within their experiment. Have the students make up a formula for calculating weight using mass and gravity.

Evaluation:

40 pts Chart of data and supporting graphs for mass vs force, and force vs mass.
10 pts Inference that the graph's slope represents the ratio of two numbers.
10pts Inference that mass has weight because gravity pulls it down.
20 pts Math showing the calculation of the slope for each graph.
20pts Accurately predict that w=mg.

Activity Ten: VECTOR X & Y COMPONENTS
Laboratory: Feeling Components of Vectors?
Time: 3 days

Using a ring stand, a scale, string, and a 1/2 meter stick. Have the student to set up the following apparatus. Attach a short string to the loop in the spring scale and attach it to the top of the ring stand. Take a long knotted string and attach a 200g mass to one end and the hook of the scale to the other end. Take a 1/2 meter stick and balance it between the stand and the string, forming a 90 degree angle with the stand. Using a protractor, measure the indicated angle Theta. Using Sin of angle theta and the known suspended force of the 200g mass as the y component; the student will calculate the expected resultant force. Read the scale and record the observed Resultant force. How does this number compare to the number they calculated (record the % error). Have the students push downward slightly on the meter stick where the weight is suspended and then release it. Have the student to pull the meter stick slightly away from the ring stand and let it go. The student should observe a spring back effect in both the horizontal and vertical directions? In their lab report they should recognize these forces as the X and Y components for the tension within the spring attached to the scale. With a ruler measure all sides formed by the triangle formed by the spring, the meter, and the stand. Using Pythagorean's theorem, calculate the hypotenuse and calculate the percent error of what was measured. Using the Tan law, calculate the degrees of theta and see how it compares to the angle that you measured.

The students will graph X and Y components for the length of each side of the triangular system and for the force vectors produced accordingly. Using a ruler, the students should measure the resultant vectors on the graph, and compare this number to the observed length of the string and reading on the scale.

Calculator Skills:

Sin b= opposite side / hypotenuse = Y/R
Cosine b= adjacent side / hypotenuse = X/R
TAN b = opposite side / adjacent side = Rise / Run = Y/X
Tan -1 (Rise/Run) = Degree of Theta

UNIT IV: Motion and Energy

All matter on earth is effected by the force of gravity giving it weight. This force of gravity may also cause motion of matter. A force is a pull or push on matter which can cause a change in its position. This unit will examine how matter changes motion. We will investigate velocity, displacement, and force vectors. The student will infer that force created by a change in motion can be use to harvest energy. Energy is the ability to do work and the work cause by moving objects can be calculated. Energy is transformed from one form to another and is conserved as all matter and energy is conserved. With several practical labs the student will see how force, motion, velocity and acceleration are related to each other.

Reference: MacMillan Physical Science, Denise Eby and Robert Horton Teacher Resource, 1986

OBJECTIVES

1. The students will be able to describe and measure motion in terms of position, time, and the derived quantities of velocity and acceleration.
2. The students will understand the relationships between motion, force, and acceleration.
3. The students will be able to construct force schematics in an effort to predict the motion of an object according to Newton's Laws.
4. The students will be able to use the conservation of energy and the conservation of momentum laws to predict conceptually and quantitatively, the results of the interactions between objects.

Activity One: Reference: MacMillan Physical Science, page 91
Laboratory:How Fast Did It Roll?
Time: 3 days

The class should lead a brief discussion on how a car gauges speed. They should all identify velocity as a vector understanding that all previous math may be related to Triangle Math. Using a book, a grooved ruler, a stopwatch and masking tape; the student will make a ramp with the ruler using the book and mark the path the marble will travel with the masking tape. Place two marks on the masking tape 5 dm apart. (Have the student to use metric conversions to infer that 5 dm is equal to 50 cm- Do not help them!! Let the class help itself discover this!!) Measure the ramp height of one book. Release the marble from the top of the ramp. When the marble reaches the first mark on the masking tape, start the clock. When the marble reaches the second mark, stop the stopwatch and record the data. Repeat this two more times and use the average results.

Repeat the procedures using two, three, and four stacked books. Record the height and time for the marble to travel 5 dm. Have the student to account for a theory that explains why the time were different. Graph the ramp height versus average speed.

Evaluation:

20pts Recognize the relationship of the average speed to ramp height.
20pts Recognize that the ball was accelerated by the pull of gravity more as the ramp became more vertical.
20pts Chart showing data and organized to show relationship of all Calculations.
20pts Sample calculations

Activity Two: Laboratory: Change Speed - Accelerate!
Time: 3 days

Reference: MacMillan Physical Science, page 97

The students will lead a class discussion inferring that gravity is a force acting on all bodies accelerating them toward the center of the earth. The student will then infer that when a force changes the speed of an object it is accelerated. With the initial speed, the final speed and the time needed to change it; you can calculate the acceleration of a marble as it rolls down a ramp. Make a track using 2 meter sticks separated by a wooden spacer held by a rubber band. arrange this system as the ruler in activity seventeen. At the beginning and end of the meter stick mark two sets of 2 dm markers with tape. These areas will be used for calculating the initial and final velocity using the procedures from Activity Sixteen. Have one student to record the path of a marble as it rolls smoothly down the beginning portion of the track, and have another student record the time traveled during the end of the journey with a stopwatch. Use the average of four trials.

Make a mark with a pencil halfway between each set of markers and record the time it takes the marble to travel between the two pencil marks. Use the average of 5 times to calculate the average time it took the marble to change from the initial to the final speed. With this information calculate the acceleration of the marble. Record the mass of the marble. Repeat this same procedure using a Metal ball. Have the student to account for any differences in their data. Also have the students vary the height of the ramp and explain what would happen to the acceleration of the ball compared to the marble. The student should infer that gravity supplied the force to move the ball.

Evaluation

- 10 pts. Calculation of Initial and final velocity
- 10 pts. Calculation of Acceleration
- 20 pts. Chart showing data for velocities
- 10 pts. Chart for Calculating average time of acceleration
- 10 pts. Infer that gravity is the factor that causes the acceleration.
- 20 pts. Support their theory with numerical data that a change in height more vertical will cause a greater acceleration due to the pull of gravity.
- 10 pts. Explain how gravity effects all matter independent to mass.

Activity Three: Gravity Systems Increase Momentum by Accelerating Mass
Time: 2 days

The students will drop a tennis ball and a super ball from their hands, at several different heights. They should then use a balance and measure the mass of the tennis ball. Using a spring scale, the students will measure the weight (downward force) that caused each object to drop from their hands. Through a guided discussion, the students should infer that weight is created by the acceleration of gravity on a mass. Thus, introduce the equation, F=ma; have the students calculate the weight of the object by multiplying its' mass by the acceleration of gravity. The students will then graph weight on the vertical axis and the measured force along the horizontal axis. The slope of the resultant line should be calculated. (there should be a one to one ratio)

Take masking tape and vertically mark the wall 2 meters up the wall. Mark the tape every centimeter. The student will drop the ball out of their hand and measure the time for the ball to hit the floor. Hold the ball at increasing heights and measure the highest height that the ball bounces on the first bounce. The student should then throw the ball downward and see how hard they have to force the ball to achieve the same heights; record as 1) small energy, 2) medium energy, 3)high energy. Have the student to calculate the final velocity of the ball when it hits the floor (V= at, initial velocity is zero), use this velocity to calculate the momentum that is transferred from the ball to the floor.(momentum = mass X velocity= initial momentum = final momentum) Graph Initial height verse final height, initial height verse momentum, and initial height verse velocity.

After a group discussion the student should infer that the faster velocity going downward or the increased kinetic energy of the tennis ball is what caused the ball to recoil to the various heights. They should infer that the floor pushed the ball upward with the same force as it initially hit the floor. The student should infer that the increased height of the tennis ball when it was dropped, caused it to have more momentum which pushed it increasingly higher off the floor

Evaluation

10 pts. Inference that gravity is acceleration because is causes masses to move at a special constant rate.
20 pts. Infer that the faster velocity going downward increased momentum
10 pts. Infer that momentum before equal momentum afterward.
20 pts. Infer that increased kinetic energy, energy of motion increased momentum
20 pts. Graphs

Activity Four: Laboratory: Forces Can Create Energy
Time: 3 days

(MacMillan Physical Science, page 103)

Using a large rubber band, a block of wood with three nails, and a spring scale; after making a sling shot apparatus, measure the amount of force required to pull the rubber band backward 1 dm. Measure the several times and use the average force. The work required to move the rubber band backward will exert and equal force on a ball as the rubber band is released and moves 1 dm back to its original position. Using a ping pong ball, shot the ball across the floor. Pull the rubber band back 0.1m and 0.05 m and compare the distance traveled across the floor. Have the student form a theory explaining why the ball moved different distances. Ask the students to identify when the ball has potential energy and when it has kinetic energy. The students should make the inference that the greater the displacement of the rubber band, the greater the energy that was exerted on the ball. This caused the ball to have different velocities as it is pushed by the rubber band, which results in different kinetic energies.

Have the students tie a sting to the ball and attach it to a ring stand. This time when the ball is propelled by the rubber band, the student should record the highest point that the ball travels through until it fall into a pendular motion. Through a guided discussion, the students will infer that for every action there is an equal and opposite reactions. Thus, the potential energy as a result of the highest vertical distance of the ball at V=0 m/s is equal to or less than the work put on the ball by the rubber band. Have the students calculate the work exerting kinetic energy by multiplying the distance traveled by the rubber band by the force exerted on the spring scale. Compare this to the calculated potential energy at the highest point by multiplying the mass of the ball, gravity, and the recorded height in meters.

Have the students graph the Work of the rubber band on the vertical axis and the potential energy of the ball on the horizontal axis. The student should calculate the slope of the resultant line. If their theory is correct, this number should be close to one. The students should make the inference that their is a one to one ratio for potential and work supplying the kinetic energy.

Evaluation:

20 pts Graph showing the resultant line and its slope.
20 pts Calculations showing potential energy and work.
10 pts Inference that Kinetic energy should equal potential energy.
10 pts Inference that work can be done by both kinetic and potential energy.
20 pts Charts showing all collected data.
10 pts Inference that the greater the force the greater the kinetic energy that is produced.
10 pts Inference that the ball moved difference distances because the greater force produced higher velocities for the ball to travel through.

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